Screening of AVT entries of Roselle (*Hibiscus sabdariffa* L.) against Foot and Stem Rot caused by *Phytophthora parasitica* var. *sabdariffae*

Abstract

Mesta or Roselle(*Hibiscus sabdariffa* L.) is one of the most important commercial fibre crop after Cotton and Jute. Foot and stem rot is one of the major devastating disease that affects the mesta plant caused by the fungus *Phytophthora parasitica* var. *sabdariffae*.Field trials were conducted at Agricultural Research Station, Amadalavalasa for two consecutive years during *Kharif* 2022-23 and 2023-24 to evaluate the Advanced Varietal Trial (AVT) entries against foot and stem rot incited by *Phytophthoraparasitica* var. *sabdariffae*in roselle under sick plot conidcitons. Six entries were screened under Advanced Varietal Trial (AVT I) and Advanced Varietal Trial (AVT II) against foot and stem rot disease of mesta under field (sick plot) conditions. In AVT I entries, the disease incidence of foot and stem rot ranged between 23.0% (AHS-340) to 42.3% (AHS-342) and the susceptible checks HS 4288 and AMV 5 recorded the disease incidence of 46.1% and 47.6% respectively. Among the six AVT II entries screened under sick plot conditions, foot and stem rot incidence ranged between 24.1% (AHS-340) to 50.6% (AHS-342). The susceptible checksHS 4288 and AMV 5 recorded the disease incidence of 50.2% and 60.0% respectively.

Keywords-Roselle,Foot and stem rot, *Phytophthoraparasitica*, Advanced varietal trial.

INTRODUCTION

Mesta or Roselle (*Hibiscus sabdarifa* L.), is one of the most important commercial fibre crop after Cotton and Jute. In trade and industry both the Jute and Mesta fibre together is known as raw jute. Raw jute/ mestafibre is mainly used in the industry in the manufacture of packaging materials.It is grown in India, Saudi Arabia, Thailand, Malaysia, Vietnam, Philippines, Sudan, Egypt, Mexico and Indonesia (Mahadevan *et al.* 2009).Mesta, aherbaceous annual plant (lignocellulosic bastfibre crop like jute) believed to be originated from Afro- Asian countries.Mesta is more adaptive and drought tolerant than jute under diverse conditions of climate and soil. Andhra Pradesh is a leading state in the country with respect to both area and production which accounts for 30 per cent of the area and 42 per cent of the production. In A.P., mesta is concentrated in Srikakulam and Vizianagaram districts accounting for 90% area of total

area in the State. Mesta comprises of two major distinct cultivated species — *Hibiscus cannabinus* L. (Kenaf, 2n = 36) and *Hibiscus sabdariffa* L. (Roselle, 2n = 72).

Most of the research on roselle has so far concerned with its antioxidant activity, health benefits, and nutritional value. But the diseases affecting roselle production is not sufficiently investigated (Hassan *et al*., 2014). The expansion of roselle planting has increased the threat of disease outbreak.Incidence of different diseases is one of the limiting factors in productivity improvement of this crop. Different diseases of mesta may witness great transformation in the backdrop of climate change with respect to intensity of incidence, development of new strains and susceptibility to the existing methods of control.Some of the common diseases of roselle reported were root rots, foot and stem rot, stem rot, leaf spot and fusarium wilt caused by *Rhizoctoniasolani*, *Sclerotium rolfsii*, *Cercosporahibisci* and *Fusarium oxysporum*respectively.Foot and stem rot is one of the majordevastating disease that affects the mesta plant caused by the fungus *Phytophthora parasitica* var. *sabdariffae*. This disease is prevalent in India, especially in areas such as Andhra Pradesh, Bihar, Odisha and West Bengal. It can cause a loss of 10–25% in fiber yield, and in severe cases, more than 40% of the crop can be lost. The pathogen when attacks the plant kills it totally thus influencing the yield. Cloudy weather from May to September, high rainfall and humidity besides, soil temperature below 30 °C may act as predisposing factor for the outbreak of epiphytotic of foot and stem rot (De and Mandal 2007b).

In this study, more emphasis was made on foot and stem rot disease incited by *Phythophtoraparasitica* var*sabdariffae*which is a soil and water borne pathogen (infection starts when there is water stagnation in the field) and marks significant yield losses (more than 40-50%) under endemic conditions (De and Mandal, 2007b). Disease development is favoured by high humidity (70-93%) and temperature range of (24-33^{0}C). Symptoms of the disease include blackening of the stems initiating from collar region which result ultimately in the death of the infected plant (Ansari *et al.*, 2013).

MATERIAL AND METHODS

Field experiments were conducted at Agricultural Research Station, Amadalavalasaunder sick plot as a rainfed crop for two consecutive years during *Kharif* 2022-23 and 2023-24 to evaluate the six AVT entries against foot and stem rot incited by *Phytophthoraparasitica* var.

*sabdariffae*in roselle.Different varieties/entireswere sown during June 2022 and June 2023 with a spacing of 30x10cm.The details of the entries are listed below in Table 1.

Each treatment was replicated thrice in a randomized block design. At the time of land preparation, NPK was applied at the rate of 30:40:40/ha out of recommended dose of 60:40:40 kg/ha. Balance amount of nitrogen was applied in two equal splits at 30 DAS and 45 DAS. Seeds were sown during June and all the entries were harvested by November. Standard scientific cultivation practices were followed uniformly for all the entries starting from field preparation, sowing, intercultural operations etc. A total rainfall of around 1030 mm has been received during the study period.Maximum and minimum temperature and relative humidity were also recorded and correlated with disease incidence (Fig 1).

Advance varietal trial is constituted by the entries promoted from Initial Varietal Trial. Limited number of entries in AVT-1 is tested along with a minimum of two checks comprising of national check and local check.Performance of entries in AVT-I will strengthen the promotion of entries to AVT-II and the promoted entries to AVT II were also studied against the incidence of FSR disease.

The observations on disease incidence of foot and stem rot was recorded at 30, 45, 60, 75, 90 DAS and at the time of harvest of the crop. The data of total plant population and number of plants effected by disease have been counted for disease incidence and converted into per cent disease incidence (DI %).

Per cent disease incidence = [(Number of plants infected / total number of plants observed) X 100]

Per cent disease Incidence	**Reaction**
0%	Immune (I)
<1%	Highly Resistant (HR)
1-5%	Moderately Resistant (MR)
6-25%	Moderately Susceptible (MS)
26 & Above	Highly Susceptible (HS)

Note: Disease rating Scale for Foot and Stem rot incited by *Phytophthoraparasitica* as pertechnical guidelines of lead centre Central Research Institute for Jute &AlliedFibres (CRIJAF).

Analysis of variance (ANOVA) was carried out on the data to test for differences using MS Excel. The significant difference between the varietal means were compared with the least significant differences (LSD) at a 5% level of probability (P#0.05)

Table 1: Entries/Varieties tested in Advanced Varietal Trials used for evaluation during kharif 2022 and 2023.

S. No.	Variety
1.	AHS 338
2.	AHS 340
3.	AMV 5
4.	AHS 334
5.	HS 4288
6.	AHS 342

RESULTS AND DISCUSSION

In the present study, Advanced Varietal Trial (AVT) of diseases tests the reaction of plants to various diseasesand quality traits (yield). The pathogenic microorganisms reduce seed germination, plant growth and yield. Pre-disposing factors like micro-climate plays a major role in the disease spread.

Effect of Weather in Disease incidence:

The maximum average temperature of 36.4°C and 31.6°C were observed during August and November months. Similarly minimum temperature of 19.5°C and 28.6°C were observed during November and October months respectively. The morning and evening relative humidity ranged from 80-87% with an average of 82.3% during morning hours whereas in the evening, RH was in the range of 57-85% with an average of 77.3%(Fig 1). Theminimum sunshine hours were recorded during the month of November (3.5hrs/day). As per the correlation studies,there was a significantnegative correlation among maximum temperature, evening relative humidity and sunshine hours per day with the disease incidence of foot and stem rot disease. Rainfall shows significant positive correlation **(0.390**)** with the foot and stem rot disease incidence.Correlation studies reported that gradual increase of disease was observed due to high rainfall and low minimum temperature.

Fig 1. Weather data (pooled) recorded during the crop growing seasons (July-Nov)

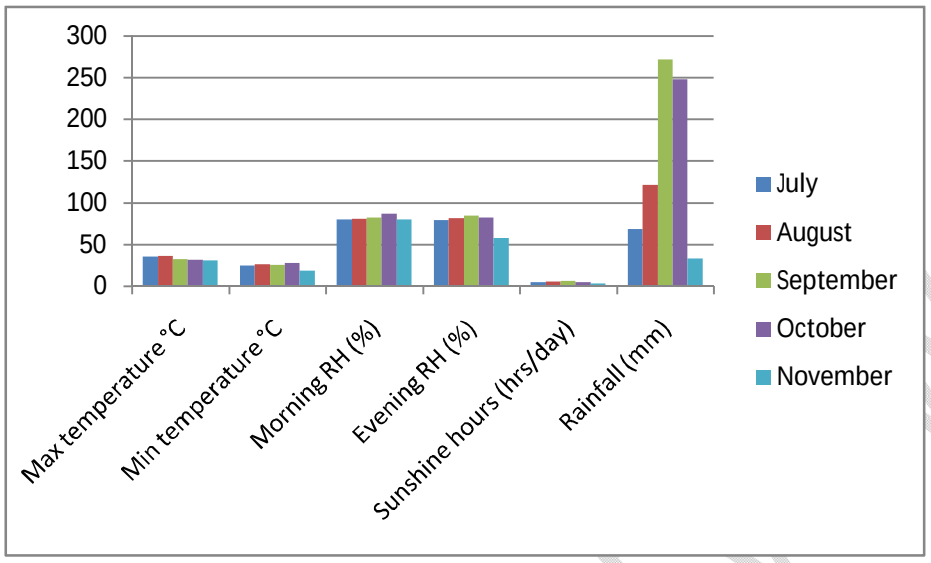

Table 2. Correlation between disease incidence of foot and stem rot of Mesta with weather parametersduring the crop growing seasons

Weather parameters	Foot and stem rot DI (%)
Max. temp. (^{0}C)	**-0.46663328***
Min. temp. (^{0}C)	**0.222077151**
Morning R.H. (%)	**0.159012656**
Evening R.H. (%)	**-0.610690268***
Rainfall (mm)	**0.390056149****

***indicates significance at 0.05** indicates significance at 0.01**

Disease incidence in different varieties/entries:

In the present study, under the Advanced varietal trial, among the sixAVT entries screened under sick plot condition for the two consecutive years, foot and stem rot disease was observed in all the entries.In AVT I entries, the diseases incidence of foot and stem rot ranged between23.0% (AHS-340) to 42.3% (AHS-342)at the time of harvest (Table 3).The entry AHS-340 is been observed with 23.0% disease incidence and least attack of foot and stem rot disease among all the other entries showing moderately susceptible (MS) reaction followed by AHS-334 (24.5%) with MS reaction. Only these two entries are noticed with least incidence of foot and

stem rot disease during the kharif 2022 sown crop. Statistically insignificant difference (on par) was observed in-between thesetwo entrieswhen compared among the other entries and withsusceptible checks. The other entries *viz.*, AHS-338 and AHS-342 were noticed with 34.1% and 42.3% disease incidence showing highly susceptible reaction.Whereas, the disease incidence in the susceptible checksHS 4288 and AMV 5were46.1% and 47.6% respectively (Table 3). Statistically significant difference was observed among these treatments when compared tochecks.

Among the six AVT II entries screened under sick plot conditions, foot and stem rot incidence ranged between 24.1% (AHS-340) to 50.6% (AHS-342)at the time of harvest (Table 3). The entry AHS-340 is been observed with 24.1% disease incidence and least attack of foot and stem rot disease among all the other entries showing moderately susceptible (MS) reaction followed by AHS-334 (25.5%) with MS reaction. Only these two entries are noticed with least incidence of foot and stem rot disease during the kharif 2023 sown crop. The other entries *viz*., AHS-338 and AHS-342 were noticed with 37.9% and 50.6% disease incidence with highly susceptible reaction. The disease incidence in the susceptible checksHS 4288 and AMV 5were50.2% and 60.0% respectively(Table 3). Statistically significant difference was observed among these treatments when compared tochecks.Similarly, the pooled mean also represents the same data, the entries AHS 340 and AHS 334 are noticed with 23.6% and 25.0% foot and stem rot incidence with MS reaction.The susceptible checksAMV 5 and HS 4288 were showing statistically significant difference with the best entries*ie.*, AHS 340 and AHS 334(Table 3). There is significant variation with the susceptible checks when compared to disease incidence of best entries.

None of the entries scored less than 5% disease incidence to designate it as a resistant line.Average yield loss due to this disease is estimated around 10–25%, which in severe cases increase up to more than 40% (De and Mandal 2007a). With the wider host range, complete resistance is not available against foot and stem rot disease ofmesta.The available roselle varieties are more susceptible to Phoma and FSR diseases in experimental fields.None of the roselle cultivars resistant to these diseases. (De and Mandal 2007a, De and Mandal 2007band Meena and Satpathy, 2018).However, many lines have been identified asmoderately susceptible against the disease.

Yield:

The effect of Foot and stem rot on yield of roselle varieties was also studied and from the pooled mean yield data of AVT I (Kharif 2022) and AVT II (Kharif 2023)experiments showedthat, the entries AHS 340, AHS 334, AHS 338 and AHS 342 has shown improved yields of 31.71 q/ha, 30.61q/ha, 32.59 q/haand29.92 q/ha respectively when compared to their susceptible checks AMV 5 (26.26 q/ha) and HS 4288 (27.78 q/ha). All the above entries has shown insignificant difference *i.e.*, there is no statistical variation among the treatments. But there is statistically significant difference among these treatments when compared tosusceptible checks(AMV 5 and HS 4288).

It is difficult to breed a resistant variety with good yield in the absence of reliable and stable source. Therefore, the germplasm lines showing moderate resistance (moderately susceptiblereaction) will be effective in improving the yields in mesta.In the present study, none of the mesta entry was found immune or resistant to the disease.Similar line of work was done by Sangeetha *et al.,* 2021.They have also screened elite entries under IVT and AVT trials against diseases of sesame. In nutshell, two entries, AVT-20-5, AVT-20-1 and in IVT trials IVT-20-17 have shown triple tolerance against root rot, Alternaria leaf spot and phyllody whereas the entries AVT-20-6, IVT-20-1, IVT-20-8 and IVT-20-10 have shown tolerance against leaf spot and powdery mildew.

Fungal root rot and wilt diseases are among the most urgent obstacles to roselle production as they attack seedlings and mature plants, causing significant yield losses.The variation in disease development mainly depends on viability of the pathogen while all other congenial environmental conditions in both of the years experiments remained same. In the field, the pathogen was favoured by high temperature and continuous drizzling. The maximum outbreak of this disease occurred when average monthly rainfall (181–227 mm) distributed over 16 rainy days and soil temperature during the period was 27–30 °C (De and Mandal 2007b). Foot and stem rot extensively affected roselle crop from seedling to harvesting stage. Susceptibility of roselle plants to foot and stem rot increased with age irrespective of variety and incidence of diseases were higher and lower according to climatic conditions. (Swathi *et al*., 2020). June–July month sown crop was more prone to foot and stem rot disease. Infected plant parts and soil debris are important source of primary inoculum than infection through seed.Therefore, these elite lines showing moderate resistance (moderately susceptiblereaction) need to be assessed for

their other yield contributing characters, so that they can be further applied in horizontalresistance breeding programmes.

CONCLUSION

Soil-borne root rot and wilt are some of the most severe diseases affecting many crops worldwide, resulting in poor production and quality, and low agricultural income. Such diseases are among the most urgent obstacles to roselle production, as they attack seedlings and mature plants, causing severe yield losses. The identification of disease resistant varieties is a major goal for agricultural scientists and plant breeders. The results of present study described the presence of sufficient genetic variation with respect to fungal diseases within the screened germplasm with a wide range ofinfection per cent.These findings provide a major incentive for breeders to plan a significant breeding program for resistance to diseases.

Table 3: Pooled data of AVT-I (2022) and AVT-II (2023) with roselle (*H.sabdariffa*) for footand stem rot disease and fibre yield.

S. No.	Variety	Disease incidence (%) of Foot and stem rot			Fibre yield (q/ha)			
		2022-23 AVT I	2023-24 AVT II	Pooled mean	2022-23 AVT I	2023-24 AVT II	Pooled mean	
		At harvest			At harvest			Reaction
1.	AHS 338	34.1^{c} (35.6)	37.9^{c} (38.0)	36.0^{c} (36.8)	39.54	25.33	32.59^{a}	HS
2.	AHS 340	23.0^{d} (28.6)	24.1^{d} (29.4)	23.6^{d} (29.0)	33.43	29.99	31.71^{ab}	MS
3.	AMV 5	47.6^{a}(43.6)	60.0^{a} (50.8)	53.8^{a} (47.2)	26.83	25.69	26.26^{d}	HS
4.	AHS 334	24.5^{d} (29.6)	25.5^{d} (30.2)	25.0^{d} (29.9)	33.88	27.34	30.61^{abc}	MS
5.	HS 4288	46.1^{ab} (42.7)	50.2^{b} (45.1)	48.2^{b} (43.9)	31.20	24.36	27.78^{bcd}	HS
6.	AHS 342	42.3^{ab}(40.6)	50.6^{b} (45.3)	46.5^{b} (42.9)	28.35	31.49	29.92^{abc}	HS
	SeM +_	1.9	1.1	1.0	1.7	1.3	1.1	
	CD (p=0.05)	5.6	3.2	3.2	5.2	4.0	3.2	
	CV (%)	10.1	5.3	5.5	10.6	9.7	10.2	

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